DOCUMENT RESUME

ED 368 488 PS 022 230

AUTHOR Kaul, Venita; And Others
TITLE Starting Children Too Early on Number Work: A Mismatch of Developmental and Academic Priorities.
PUB DATE [91]
NOTE 22p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Age Differences; Comparative Analysis; *Developmental Stages; Foreign Countries; Learning Readiness; Mathematics Education; *Mathematics Instruction; Mathematics Skills; *Number Concepts; *Preschool Children; Preschool Education; Process Education; *Program Effectiveness; Socioeconomic Status
IDENTIFIERS Academic Orientation; Developmentally Appropriate Programs; *India; *Mathematics Readiness

ABSTRACT

Noting a developmentally inappropriate trend toward earlier instruction in mathematics, a study examined the effects of a systematic, process-based, developmentally appropriate program for the development of number readiness in Indian kindergarten (preschool) children aged 4 and 5. An experimental group of 20 children received the process-based number readiness intervention, while 3 control groups received normal mathematics instruction. Control subjects were: (1) students of similar background at the same school; (2) students of a higher socioeconomic background attending an elite private school; and (3) students of similar background attending a lower quality school. All children were evaluated individually on their number readiness and their number concept knowledge. Results indicated that the experimental group performed better than the control groups on most measures of number readiness and number concept knowledge. (MDM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 368 488

STARTING CHILDREN TOO EARLY ON NUMBER WORK: A MISMATCH OF DEVELOPMENTAL AND ACADEMIC PRIORITIES

*Venita Kaul
Romila Bhatnagar
Sangeeta Tolani

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
X This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

1. Introduction

1.1 The Academic Priority:- At the primary stage of education curricular experiences pertaining to mathematics have all along occupied a predominantly significant role. In today's world the study of mathematics has become even more indispensable due to its wide ranging applications in the context of the modern technological advancements and demands. Application of knowledge and skills in mathematics is required in the day-to-day transactions in the form of measurement, organization of data, interpretation of data, estimation and problem solving, as well as making inferences and predictions. In the context of the changing needs of society and the constant exposure of the vast amount of quantitative data, mathematics is visualized as "a vehicle to train a child to think precisely and logically, to reason and to use quantitative measurements and treatments for solving problems faced in real life situations. The study of mathematics at the primary stage, therefore, is expected to lay the foundation of mathematical thinking about the numerical and spatial aspects and relationships among the objects and activities which children at this stage would encounter" (Dave et al, 1991).

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Venita Kaul
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

PS 022230

BEST COPY AVAILABLE

A child enters the primary stage at the age of 5 or 6 years in Class I. This is officially recognized as the child's entry point to the formal stage of education. But unfortunately in practice today, particularly in the urban situation, more and more children are entering the stage of formal schooling in the preschool itself, as early as at the age of 4 years/3 years and in some cases even 2 years! A recent survey of some schools of Delhi has indicated that formal teaching of numbers and number work is being introduced as early as at the 3+ stage without giving the child any preceding experiences to ascertain or develop the child's readiness (Kaul, 1989). As a result a child's entry level attainment in Class I already amounts to counting of objects numbering from 1 to 20 or even 50 and recitation and writing of numerals upto 100! In some cases children have already 'mastered' simple addition and subtraction problems as well! The preschool curriculum thus demonstrates a definite downward extension of the primary grades' curriculum.

1.2 The Developmental Priority: From the point of view of child development, this acceleration or trend of early instruction which has today become the norm rather than the exception, is a matter of great concern. A very crucial and established factor influencing any learning is the maturational and experiential readiness of the child. This is particularly

so for learning of concepts and even more so for learning of the number concept which should logically be preceded by mastery of certain prerequisite concepts, skills and vocabulary.

The child at the preschool stage is at the preoperational stage of cognitive development when his thinking is limited/dominated by his/her perceptions. The child is not able to mentally reverse thought processes or logically sort through solutions. At this developmental stage, the child is also able to pay attention to only one attribute at a time. Consequently, while the older child in the primary grades may be able to look upon a collection of six objects as having the same number no matter how the objects are arranged, the child at the preschool stage may not be able to do so. In other words, he is not able to 'conserve' number. Most children in India have been normally found to conserve number only by about the age of seven years (Bevli et al, 1990). If a child is taught numerals before he/she has developed this competence of 'conservation' he is likely to have difficulty understanding that numerousness of two sets is the same or, in other words, develop the full concept of number.

1.3 Mismatch of Priorities: Advancing of the age of introduction of formal learning is 'justified' in terms of the

need to meet the demands of the phenomenal knowledge explosion in the years to come ! Children at the preprimary levels are often expected to start working on workbooks involving abstract representations and symbols even before they have gained any knowledge or familiarity with the basic concepts or principles that these exercises are attempting to expand. It is even possible that they may be trying to learn and memorize mathematical symbols even before they have anything to symbolize! According to some educationists "this is known to result in developoment of a dislike or fear of mathematics which becomes permanently fixated as early as the ages of six and eight!"

While mathematics, per se, involves abstract and symbolic thinking, it is in essence rooted in the concrete experiences that children have with quantitative qualities of objects they have in their environment. Therefore children learn best through experimentation and exploration of their environment. It is through such manipulation and experimentation that children develop the necessary 'pre number' concepts that pave the way for an understanding of the more complex mathematical principles. It is believed that if arithmetic is imposed on children before they have developed these 'pre number concepts' they end up simply memorizing and are likely to gradually run into trouble later when they are expected to apply their knowledge to more advanced levels of reasoning.

The initial mathematical experiences of a child should therefore include experiences for development of basic linguistic and conceptual readiness for numbers which should be developed in children through a systematic process-based approach. The process approach should help children arrive at answers to their questions through exploration, observation and investigation as they deal with concrete objects and experiences.

2. OBJECTIVES OF THE STUDY

This study was conceptualized in the above context. Its major objective was to develop and empirically try out and evaluate a systematic, process-based programme for development of number readiness and subsequent number concept in children at the preprimary stage.

3. METHODOLOGY

3.1 Sample: The experimental design was followed. Two sections of the Kindergarten class in the laboratory nursery school of the department were selected as the experimental group. The children in these sections were primarily of Class IV government employees. The fathers had received school education while the mothers were, in many cases, illiterate. Two other sections of the same nursery school which were catering to children from a similar socio economic background

were treated as the first level of control. Comparisions were also made with a group of children matched on age and socio economic status from a Corporation Nursery School and another group matched on age but from a higher socio-economic status attending an elite private school. These were mainly children of professionals and Class I officials. Table I gives the details of the sample:-

Table I : Showing details of Sample.

Sample = 60 Children

Experimental Group	Control 1	Control 2	Control 3
20	20	10	10

1. Control group 1 : Matched on Age, SES & School
2. Control group 2 : Matched on Age only. High SES and elite school.
3. Control group 3 : Matched on Age, SES & School of a lower quality.

3.2 Intervention

The experimental group with whom the process based programme was systematically transacted, comprised of two

sections of the K.G. Class of 4 to 5 year Olds. Each class consisted of about 30 children. For the purpose of evaluation however, ten children were randomly selected from each of the two sections.

The process based programme that was developed and tried out focused on

3.2.1 Development of Linguistic Readiness.

3.2.2 Development of Conceptual Readiness

a) Concepts related to the environment

b) Concepts related to relative locations/positions/space.

c) Concepts related to quantitative dimensions i.e. the conventionally known pre-number concepts

d) Concept of group/set

e) Concept of one to one correspondence

f) Concept of equivalence

g) Concept of number through rote and rational counting

h) Development of number concept

i) Number properties and operations.

3.2.3 Development/Strengthening of Cognitive Skills

a) Classification

b) Seriation

c) Pattern making/Sequential Thinking

d) Logical Relations

e) Conservation.

The activities in the course of the intervention were all planned in accordance with these specified objectives. The major focal points in planning were:

- the activities should be interesting and provide fun to the children.
- they should involve direct manipulation and activity on the part of the children
- they should be planned sequentially from the concrete to the abstract level i.e. through the following stages:-
  * Children themselves
  * concrete objects in the environment
  * pictures of objects
  * pictures of geometrical shapes and figures
  * abstract signs and symbols on the blackboard.

For the concept development activities the programme was systematically sequenced through the following stages-

* Matching (at the perceptual level)
* Identification (Including the language label in passive vocabulary)
* Naming (using language label in active vocabulary)
* Seriation (arranging in order/gradation).

The activities introduced with the children to cover the laid-down objectives included:-

* Structured conversation
* Picture Reading
* Stories and rhymes
* Dramatization
* Games and play activities
* Activities with teacher-made material which specifically involved matching, identification, naming, seriation and classification skills. They also included activities for sequential thinking and problem-solving.
* Nature walk and excursions

3.2.4 Number Readiness Profile:

Both teachers of the experimental sections systematically planned, carried out activities and evaluated the learning outcomes consistently in accordance with the specified objectives and guidelines. A number readiness profile of each child was maintained in terms of the concepts and cognitive skills.

3.3 Hypotheses: The hypotheses subjected to examination in the study were

1. Children exposed to the process based readiness programme will demonstrate better understanding of

the cardinal value of number, irrespective of SES and type of schooling.

2. Children exposed to the process based readiness programme will demonstrate better understanding of the ordinal value of number, irrespective of SES and type of schooling.

3.4 Evaluation Tools:

The evaluation was conducted at two level:-

1. to assess the quality of 'readiness' attained for number work in terms of the specified concepts and cognitive skills.
2. to assess the quality of acquisition of number concept as an outcome of the expected 'superior' level of readiness.

The tools/tests for evaluation were again framed at two levels - 'concrete' and 'abstract'. The concrete testing situation involved manipulation of concrete objects from the environment. The 'abstract' evaluation was done through specially prepared worksheets. The 'concrete' testing situation was resorted to only if the child was not able to perform through the worksheets. The scores were accordingly assigned i.e. 2 for correct response at the 'abstract' level, 1 for 'concrete' level and '0' for incorrect response.

The evaluation covered the following variables under study:-

	Level 1 Number Readiness	Level 2 Number Concept
1.	Pre Number Concept(Seriation)	* Rote Counting
2.	Space Concepts	* Rational Counting
3.	Classification	* Matching Quantities
4.	Problem Solving	* Numeral Object Matching
5.	Pattern making/sequential thinking	* Relative Comparisons
6.	One to one correspondence	* Order of Number
7.	Conservation	* Writing of Numerals.

The testing of children was done on an individual basis. The variables related to number readiness were evaluated at the start of the last academic quarter. The testing schedules were maintained consistent for the control and experimental groups to eliminate the influence of even minor variations in age of the children since at this stage even a month's difference in age makes its impact. The testing for number concept was done towards the end of the academic year just prior to entry to grade I.

4. RESULTS OF THE STUDY

The data obtained on both sets of variables was tabulated and means and S.D.'s were worked out for each variable separately for each of the four groups (ref. Tables 2 to 4). The means were subjected to the t-test of significance.

4.1 Number Readiness

Tables 2,3 & 4 describe the comparative results obtained on the variables related to Number Readiness:-

Table 2 - Showing comparative means of the Experimental and Control group 1 for each of the readiness variables.

Variables	Exp. Group Mean	S.D.	Control group 1 Mean	S.D.	t
Seriation	47.7	6.09	38.6	11.86	3.1**
Classification	5.2	1.36	3.8	1.69	2.91**
Problem Solving	15.7	2.72	13.9	5.67	1.28n.s.
Pattern making/ Sequential thinking	3.87	2.45	.92	.89	5.08**
Space concept correspondence	28.15	4.09	22.8	7.59	2.7**
One to one	7.6	1.2	6.1	2.93	2.14**
Conservation	-	-	-	-	-

*< .50
**< .01

Table 3 : Showng Comparative Means of the Experimental Group and Control Group 2 for each of the readiness variables.

Variables	Exp. Group Mean	S.D.	Control Group 2 Mean	S.D.	t
Seriation	47.7	6.09	44.4	5.08	1.57
Classification	5.2	1.36	4.2	1.53	0.9
Problem Solving	15.7	2.72	16.25	2.15	0.6
Pattern Making/ Sequential thinking	3.87	2.45	1.65	0.63	3.83**
Space Concept	28.15	4.09	26.6	3.7	1.04
One to One Correspondence	7.6	1.2	7.6	1.2	-
Conservation	-	-	-	-	-

Table 4 : Showing Comparative Means of the Experimental Group and Control Group 3 for each of the readiness variables.

Variables	Exp. Group		Control Group 3		t
	Mean	S.D.	Mean	S.D.	
Seriation	47.4	6.09	27.8	18.2	5.0**
Classification	5.2	1.36	2.7	1.53	2.94**
Problem Solving	15.7	2.72	10.1	6.45	2.64**
Pattern making/ Sequential thinking	3.87	2.45	0.2	0.6	6.35**
Space Concept	28.15	4.09	14.5	11.78	3.5**
One to One	7.6	1.2	3.6	2.8	4.13**
Conservation	-	-	-	-	-

**< .01 Level of significance.

As indicated in Tables 2,3 and 4 the experimental group does generally demonstrate a superior level of number readiness in terms of the different cognitive skills as compared to the control groups.

4.1.1 Experimental Group Vs. Control Group 1

To consider the comparative status of the experimental group vis-a-vis each control group separately, Control group 1 is comparised of children matched exactly with the experimental group on age (in terms of years and months), socioeconomic status (children of Class IV employees) and school (same laboratory nursery school). The kind of preschool education programme to which this control group was exposed was also a play and development oriented programme. It differed, however, from the experimental group's programme in that the introduction of activities for the different cognitive skills,

though included, was not systematic and sequenced. Secondly, number concept activities were introduced alongside the number readiness activities right from the start without first ascertaining the readiness for these experiences in the children.

The comparative results, as indicated in Table 2, show the experimental group to be significantly higher on all the skills/concepts excepting on problem solving for which also the mean of the experimental group is higher.

4.1.2 Experimental group Vs. Control Group 2:

Control group 2 consisted of children drawn from an elite private school and belonging to the upper - middle SES stratum. The children were matched exactly on age, in terms of years and months, with the experimental group. The preschool education programme followed was a formal one with stress on the learning of the 3 R's. At the time of evaluation, these children in this school had already covered number work upto 100 and were on to simple addition and subtraction. There was little stress on process oriented cognitive development activities in the programme.

The results, as demonstrated in Table 3 indicate that the experimental group, despite its lower socio economic background and concomitant deterrents, performed significantly higher on

BEST COPY AVAILABLE

sequential thinking and pattern making as compared to the control group (.>.01). The performance of the experimental group on 'Seriation' was also better than the control group although the difference did not reach the level of significance. The sample size of the control group was only 10 (due to the intensive, individualized testing procedure). It is possible that the differences may reach a significant level with a larger sample size. The trend of differences between means, for the other variables also is consistently in favour of the experimental group, excepting for 'problem solving' where the control group has a slight edge, and one-to-one correspondence for which the means are equal.

The point worthy of reiteration is that in this comparison, it is the intervention that has enabled the experimental group which was from the low socioeconomic stratum, to come up to the level of their higher SES counterparts, and in certain cases even excel them in these cognitive skills.

4.1.3 Experimental Group Vs. Control Group 3:

Control group 3 consisted of children drawn from the lower socioeconomic stratum comparable to the experimental group. These children were attending a preprimary class in a corporation primary school. The programme followed in the school was sub-standard and not very stimulating. The teacher

was often absent and the children were left on their own or asked to write on their slates.

As indicated in Table 4, the experimental group did significantly better on all variables as compared to this group, which underlines the crucial significance of stimulating experiences over and above the maturational factor, in cognitive development.

4.1.4 Conservation: On conservation of liquid and number, which was assessed through the Piagetian tasks, the children in all the four groups demonstrated inability to conserve. This observation was consistent with the finding that conservation of solids, liquid and number is demonstrated by children only by the age of 7 to 8 years (Bevli et al, 1990).

4.2 Acquisition of the Number Concept

The major hypothesis subjected to examination in this study was that the children who are exposed to the process based readiness programme will demonstrate a better understanding of the cardinal and ordinal value of number, irrespective of SES and type of schooling.

Table 5 gives the comparative performance of the experimental group vis-a-vis the three control groups on the separate number-related tasks on which they were evaluated.

Table 5: Showing comparative means
for Number Concept related tasks

Tasks	Exp.Group M.	SD	Control M	SD	Group 1 t	Control M	SD	Group2 t	Control M	SD	t
Rote Counting	9.35	1.2	6.3	4.25	3.1**	10	0	1.03	0	0	-
Rational Counting	7.9	1.63	5	3.24	3.6**	5.3	2.87	2.74**	0	0	-
Matching Quantities	8.5	1.71	4.75	4.52	3.5**	6	2.33	3.25**	0	0	0
Numeral object matching	9.0	1.34	4.55	3.59	4.19**	7.2	2.9	1.89	0	0	-
Relative Comparaisons	5.5	4.36	4.35	4.2	.83	3.1	3	1.73**	0	0	-
Order of Numbers	8.9	3.3	4.75	3.13	3.23**	6.7	4.3	1.42	0	0	-
Writing of Numbers	7.6	2.8	5.5	4.4	1.81**	9.4	0.8	2.18*	0	0	-

** <.01

** <.05

As indicated in Table 5, in Control group 3 i.e. from the Corporation School, absolutely no learning had occurred so far as number work was concerned. Further analysis was therefore

not required. The evaluation was based on only numbers upto 10. In terms of the cognitive skills i.e. number readiness also, this group had demonstrated a significantly poorer level as compared to the experimental group.

With respect to Control Group 1 which was drawn from the same Nursery School and had been follwing a 'not-so-systematic' play oriented readiness programme, the experimental group emerged significantly superior on all tasks excepting 'relative comparisions'. The hypothesis therefore gets substantiated that children exposed to the process based programme developed in this study, would demonstrate a better quality of concept formation of the cardinal and ordinal value of number.

In the comparision with Control group 2, in which both SES and type of schooling were not controlled also, it is interesting to observe that it is specifically in the tasks involving 'concept or understanding of number that the experimental group demonstrates a significantly superior performance eg. rational counting, matching quantities, numeral-object matching and relative comparisons. In other tasks which were dependent on rote learning the Control group did better eg. rote counting, or writing of numbers in which they had been given practice right through the year. For order of numbers, though the difference was not significant, it was still in favour of the experimental group.

5. CONCLUSIONS

1. The study substantiates the hypothesis that irespective of SES and type of schooling, the children exposed to the number readiness programme will demonstrate better understanding of the concept of number.
2. This implies that it is not only the maturational aspect or even a generally enriched, stimulating environment (as in the case of Control group 2) that are the catalytic factors but a specific, systematic cognitively-oriented readiness programme that must imperatively precede learning of numbers.
3. As evident from the results obtained on the number readiness aspect, (Tables 2,3 and 4) while all specified skills/concepts are relevant and important, the two cognitive skills which need particular emphasis in the context of number concept and number operations are seriation and sequential thinking. Activities to promote these skills must form a part of every preschool education programme.

   Classification is another skill which has direct relevance for understanding the number clusters or 'sets'. While some opportunity for using this skill does arise inevitably from day-to-day

situations, particularly in the case of children from higher social strata, systematic practice in it can enhance the skill as evident from the higher means of the experimental group.

4. The results on Conservation indicate that children at this age, irrespective of SES are not able to conserve number. Yet, they are given instruction for not only learning of numbers upto 100 but even performing the arithmetical operations with them (Control group 2). This raises the very fundamental question that, with the children evidently needing appropriate maturational and experiential readiness for learning numbers, would it not be wiser to wait till they are 6½ or 7 years old before introducing numbers rather than ignoring their developmental and experiential status ? Imposing this academic load on them too early will inevitably lead only to promotion of the 'Cumulative deficit phenomenon' as is sadly evident in large measures in the primary grades today!

A E·F E R E N C E S

1. BEVLI, U. et al The Growth of Logical Thinking in Children. NCERT, 1990

2. DAVE, P.N. et al. Minimum Levels of Learning at The Primary Stage, NCERT, 1991.

3. KAUL, V. Pressures on the Young Child. Background Paper for Seminar for Principals in ECE Unpublished.